

Conference Report

Gordon Research Seminar on Physical Virology 2017

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This year the biennial Gordon Research Seminar (GRS) and Conference (GRC) on ‘Physical Virology’ took place for the first time in Europe at the conference site Renaissance Tuscany Il Ciocco in Barga, Italy, from Jan 28th to Feb 3rd. Virology is an inherently interdisciplinary field, and this GRC was first introduced in 2009 with the goal of creating a forum for virologists, chemists, bioengineers, physicists and materials scientists to increase communication between these various disciplines. As the beneficial attributes of viruses, such as their well-defined monodisperse structures and self-assembling properties, are increasingly recognized for the design of advanced nanoscale materials, different perspectives on virus structure and function help foster innovative research with broad applications in material science and biomedicine.



The 2017 GRS/GRC on Physical Virology was held for the first time in Europe at a site near Lucca in Italy, overlooking the beautiful Serchio valley.

Typically, a GRC is preceded by a two-day GRS, a seminar that is organized by junior scientists to create an exciting and unintimidating atmosphere for other young researchers with comparable levels of experience and education. This year’s Virology GRS, chaired by Anna Czapar (PhD student at Case Western Reserve University) and Raphael Frey (PhD student at the ETH Zürich), was generously supported by the Swiss Chemical Society, the KGF member companies Roche and Novartis, Case Western Reserve University and the ETH Zürich. To promote the free exchange of ideas and discussion of cutting-edge, unpublished research, GRC and GRS have an ‘off-the-record’ policy which prohibits the recording or reporting of data presented. This seminar report is, therefore, limited to the general themes covered during the meeting and aims at giving an impression of the great diversity of topics centering around viruses and virus-inspired materials.

A total of 45 PhD students and post-docs found their way to wintry Tuscany to participate either as a speaker or poster presenter in the seminar. In addition, Prof. Mauri Kostianen (Aalto University, Finland), Prof. Tuli Mukhopadhyay (Indiana

University Bloomington, USA), Prof. Mavis Agbandje-McKenna (University of Florida, USA) and Prof. Adam Zlotnick (Indiana University Bloomington, USA) were invited as mentors to provide research input during the student talks and poster sessions as well as valuable advice on career planning. The seminar opened on Saturday afternoon with the first highlight: the keynote lecture by Prof. Mauri Kostianen, who uses synthetic building blocks in combination with biological macromolecules such as DNA and viruses to create highly ordered nanostructures. In his talk, Prof. Kostianen showed that crystalline binary superlattices can be formed using the protein capsid from the cowpea chlorotic mottle virus (CCMV) and positively charged gold nanoparticles that interact with negatively charged patches on the CCMV protein surface.^[1] He further showed that the same principle of electrostatically driven assembly can be used to build a multicomponent crystal consisting of oppositely charged CCMV virus particles and avidin, which enables functionalization of the resulting nanomaterial through avidin-biotin technology.^[2]



Poster sessions were an integral part of the seminar creating opportunities for networking and future collaborations.

The keynote session was followed by a 90-minute poster session, in which the first half of the more than 40 posters was displayed. Encouraged by local Tuscan wine, the poster display area became an engaging site for lively discussions, in which the poster presenters obtained direct feedback and suggestions from their peers working on similar problems.

In the following evening session, five junior scientists, who were selected based on their abstracts, talked about more fundamental research on virus capsid assembly and structure. Diana Born from the Max Planck Institute in Heidelberg discussed her studies on the assembly of virophages, a kind of satellite virus that depends on co-infection by another virus. Nikea Pittman, PhD student at the University of Florida, presented her work on the structural characterization of a virus with oncolytic activity, a promising new class of biotherapeutics for the treatment of cancer. Other topics included molecular dynamics simulations

of the fusion process of influenza virus with its host cell, as well as assembly of artificial virus mimics and virus-templated assembly of helical superlattice wires. A group dinner concluded this interesting first day.

The morning session of the second day was dedicated to viral and virus-like materials for applications in nanotechnology and medicine. Claudia Koch from the University of Stuttgart opened the proceedings, giving an overview over the incredibly diverse applications of biomaterials derived from tobacco mosaic virus (TMV). In order to functionalize TMV, she used a variant that has a cysteine on each of its several thousand capsid building blocks. Upon biotinylation this variant can be used to immobilize streptavidin-conjugated enzymes for biosensing applications.^[3] TMV and other virus-based particles have emerged as a promising platform for the development of biotherapeutics and diagnostic tools due to their innate biocompatibility, homogeneous size and the possibility of chemical or genetic modification.^[4] However, viruses are naturally immunogenic and while this can be advantageous for the development of immunotherapeutics, it is often a limitation in other applications such as drug delivery or imaging. Andrzej Pitek from Case Western Reserve University presented an approach to avoid this limitation by coating TMV with serum albumin, an abundant protein in the blood serum. These 'camouflaged' TMV particles showed decreased antibody recognition and improved pharmacokinetics.^[5] In order to avoid the innate immunogenicity of virus-like particles, Tom Edwardson, post-doc at the ETH Zürich, is investigating a non-viral computationally designed protein cage as a delivery vehicle for nucleic acids. Such artificial systems have the potential to mimic viruses in their function but avoid the drawbacks often encountered with virus-based platforms. The two other talks held in this session were given by Aijie Liu from the University of Twente, who converted CCMV into a nanoreactor for the catalytic reduction of nitroarenes through encapsulation of gold nanoparticles,^[6] and Samuel Jones from the EPFL Lausanne, who reported exciting work on a nanoparticle-based virucidal agent that acts against a broad range of viruses. The morning session was concluded by the second poster session.

After lunch, our invited mentors assembled for a panel discussion to elucidate career options in the field of virology and to give advice for those aspiring to pursue an independent research career. The mentors introduced themselves and briefly summarized their professional history. Different perspectives were provided as the panel included both younger PIs and professors who have been pursuing independent research for more than 20 years. Two of the mentors, Prof. Mavis Agbandje-McKenna and Prof. Adam Zlotnick, are also co-founders of biotech companies and were able to provide insights into alternative career paths. In the following discussion, the question of how to negotiate for money with institute directors when starting one's own group arose. The take-home message given by the four mentors can be best summed up with the statement: Don't be shy to ask for enough money!



Besides talks and poster presentations, the meeting included a panel discussion on job prospects in the field of virology and related areas. From left to right: Prof. Mavis Agbandje-McKenna, Prof. Adam Zlotnick, Prof. Mauri Kostianen and Prof. Tuli Mukhopadhyay.

Before the 2017 GRS on Physical Virology officially ended, the chairs for the next meeting were selected by the plenum. The Virology GRS which is expected to take place in 2019 in Ventura, California, will be chaired by Stephan Tetter (ETH Zürich) and Lakshmi Nathan (Cornell University, USA). After one and a half days of a quite intense meeting schedule, the participants spent the rest of the afternoon exploring the Tuscan surroundings or simply enjoying the hotel's spa and gym facilities in anticipation of the associated GRC on Physical Virology that was scheduled to start on the same evening.

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